

METHOD, SYSTEM AND STORAGE MEDIUM FOR AUTOMATED  
INDEPENDENT TECHNICAL REVIEW

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of United States Provisional Patent Application Number 60/221,438 filed on July 28, 2000, and United States Provisional Patent Application Number 60/221,018 filed on July 27, 2000, the entire contents of which are incorporated herein by reference.

BACKGROUND

[0002] The management of hazardous waste materials, including radioactive waste, is important to maintaining the environment. Radioactive waste can be defined as any material that contains or is contaminated by radionuclides at concentrations or radioactivity levels greater than a particular level set by the government. This level set by the government is based on a determination of what constitutes an unacceptable level of risk to the environment. In addition, radioactive waste is material that has no foreseen future usefulness. Waste disposal refers to placing the radioactive waste in approved radioactive waste containers, at approved sites, without the intention of retrieval. Making sure that the radioactive waste containers are secure raises special concerns because some nuclear waste materials retain high levels of radioactivity for thousands of years.

[0003] There are numerous tools that can be used to monitor the radioactive content of waste being disposed of in the radioactive waste containers. For example, counters are used to measure the radiation of the contents of a radioactive waste container and various other parameters. Typically, the contents are checked to ensure that they meet various regulatory limits as set by the Environmental Protection Agency and the Department of Energy. Another type of check that is done on the counter data is a verification that the testing performed by the counter reflects the actual contents of the radioactive waste container. Both of these types of checks are currently performed

manually and are prone to human error. In addition, because of the manual nature of the checking, the process takes a relatively long time and this makes it difficult to process and interpret large volumes of data in a timely fashion.

## SUMMARY

[0004] An exemplary embodiment is a method and system for performing an automated independent technical review. The method includes receiving an assay result of a radioactive waste container, determining whether the assay result is within a predetermined parameter, determining whether a review is required if the assay result is not within the predetermined parameter and rejecting the assay result if the review is not required and the assay result is not within the predetermined parameter.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0005] Referring now to the drawings wherein like elements are numbered alike in several FIGURES:

[0006] FIG. 1 is a block diagram of an exemplary system for performing an automated independent technical review.

[0007] FIG. 2 is a flowchart of an exemplary process for performing an automated independent technical review.

[0008] FIG. 3 depicts an exemplary independent technical review template.

[0009] FIG. 4 depicts an exemplary independent technical review comment template.

## DETAILED DESCRIPTION OF THE INVENTION

[0010] FIG. 1 is a block diagram of an exemplary system for performing an automated independent technical review. The system of FIG. 1 includes user systems 102 through which a waste analyst will contact a host system 104. In a preferred embodiment, the host system 104 executes a program that performs an automated independent technical review. The user systems 102 are coupled to a host system 104 via a network

106. Each user system 102 may be implemented using a general-purpose computer executing a computer program for carrying out the processes described herein. The user systems 102 may be personal computers or host attached terminals. If the user systems 102 are personal computers, the processing described herein may be shared by user system 102 and host system 104 by providing an applet to the user system 102.

[0011] Network 106 may be any type of known network including a local area network (LAN), a wide area network (WAN), or a global network (e.g., Internet). The user system 102 may be coupled to the host system 104 through multiple networks (e.g., intranet and Internet) so that not all user systems 102 are coupled to the host system 104 through the same network. One or more of the user systems 102 and the host system 104 may be connected to network 106 in a wireless fashion and network 106 may be a wireless network. In a preferred embodiment, network 106 is an intranet and each user system 102 executes a user interface application (e.g., web browser) to contact the host system 104 through the network 106. Alternatively, a user system 102 may be implemented using a device programmed primarily for accessing network 106 such as WebTV.

[0012] FIG. 1 also depicts the sources of data for an automated independent technical review in an exemplary embodiment of the invention. The data can come from a variety of computer systems across the network 122 or the data could come from the storage device 108 attached to the host system 104. In an exemplary embodiment, the data required for an automated independent technical review is identified and subsequently gathered into a single, relational database stored on a storage device 108 connected to the host system 104. The item description code data 114 includes a list of valid materials that can be measured. The counter data 116 includes the assay results or measurement data taken by a counter for a particular radioactive waste container. The isotopic measurement data 118 is either data collected using an isotopic measurement system or default regulatory values if no measurement data is available. The regulatory data 120 includes limits set by the government. This automated independent technical review data can be gathered from locations around the world and then consolidated into a

single database stored on a storage device 108 connected to the host system 104.

Regulatory data 120, for example, may come from a variety of locations. The automated independent technical review data is gathered in response to a user system 102 request.

**[0013]** The network 122 used to transfer the automated independent technical review data has the same attributes as the network 106 described above and could be the same physical network. This network 122 may be any type of known network including a local area network (LAN), a wide area network (WAN), and a global network (Internet). The automated independent technical review data may be transferred to the host system 104 through multiple networks (e.g., intranet and Internet) so that not all the automated independent technical review data is transferred to the host system 104 through the same network. One or more of the remote systems may be connected to the network 122 in a wireless fashion and network 122 may be a wireless network.

**[0014]** The host system 104 may be implemented using a server operating in response to a computer program stored in a storage medium accessible by the server. The host system 104 may operate as a network server (often referred to as a web server) to communicate with the user systems 102. The host system 104 handles sending and receiving information to and from user systems 102 and can perform associated tasks. The host system 104 may also include a firewall to prevent unauthorized access to the host system 104 and enforce any limitations on authorized access. For instance, an administrator may have access to the entire system and have authority to modify portions of the system. The firewall may be implemented using conventional hardware and/or software as is known in the art.

**[0015]** The host system 104 also operates as an application server. The host system 104 executes one or more computer programs to perform an automated independent technical review. Processing may be shared by the user system 102 and the host system 104 by providing an application (e.g., java applet) to the user system 102. Alternatively, the user system can include a stand-alone software application for performing a portion of the processing described herein. It is understood that separate servers may be used to implement the network server functions and the applications

server functions. Alternatively, the network server, the firewall, and the application server can be implemented by a single server executing computer programs to perform the requisite functions.

**[0016]** In an exemplary embodiment of the present invention, the host system 104 contains a suite of application programs that create an automated technical review report. The application programs and a software template are used to create a report that contains assay results, comparison results, and other data regarding a particular radioactive waste container. The comparison results are created using predetermined parameters and data values that can include values stored in data files, values or assay results created by a counter system, and data values calculated by application programs. A comparison test can have three possible results: (1) "assay acceptable" okay to ship the radioactive waste container; (2) "expert review required" before shipping; or (3) "reject" the test results because the data is faulty. If all tests results for a particular container are assay acceptable, then the final disposition on the report will indicate that the assay review is acceptable. If any test result is "expert review required", an independent technical review comment sheet will be generated and the final disposition will indicate that the expert review is required. Expert review is defined as a recommendation for human intervention before shipping the radioactive waste container. A person is advised to review the test results and make a determination of the status of the radioactive waste container if the test result is "expert review required." If any test result indicates a reject, the final disposition will be to reject the assay. If the disposition is reject, generation of an independent technical review comment sheet will be suppressed.

**[0017]** In an exemplary embodiment, one of the applications on the host system 104 performs an item description code comparison to determine if the material in a radioactive waste container can produce acceptable assay results. The application compares an item description code for a particular radioactive waste container with a list that contains the item description codes for the types of materials that can be measured by a particular counter. If the item description code of the radioactive waste container is not found, then the result of the comparison will be "expert review required." Otherwise the

output of the comparison is the result “assay acceptable.” An example of this would be a gamma counter, that generates a gamma radiation assay result, and a radioactive waste container that contains lead. Here, the result would be “expert review required” because the item description code “lead” would not listed in the gamma counter list of acceptable item description codes. Lead would not be in the list because, in general, lead is too dense to be measured by a gamma counter. Note that one skilled in the art can readily obtain the measurements necessary for use in the tests described herein using commercially available measurement equipment, routine experimentation and/or analysis. Further, one skilled in the art can perform the tests and analyses described herein without involving extensive experimentation.

**[0018]** Another application program, in an exemplary embodiment, takes data from an isotopic measurement system and calculates the ratios of  $\text{Pu}^{239}$  and  $\text{Pu}^{240}$ . Based on the results of the comparison, the test data is flagged as “assay acceptable” or as “expert review required.” The review sheet will print whether the measured isotopics or the default isotopics are being used based on whether the relative error for the  $\text{Pu}^{240}$  is greater than about 70%. If this condition exists or if no measured isotopics results are available then the report will display that default isotopics are used. In an exemplary embodiment of this application, a weapons grade plutonium test is applied when the default isotopics are not used. In this test, the absolute 3-sigma error for  $\text{Pu}^{240}$  is calculated. The 3-sigma error is added to and subtracted from the measured weight percent for  $\text{Pu}^{240}$  to produce a range. If the accepted weapons grade weight percent falls within this range, the result is “assay acceptable.” If it falls outside of this range the test result is “expert review required.”

**[0019]** In an exemplary embodiment of the present invention, another application on the host system 104 performs comparison of assay result container density data in order to determine if it is within a predetermined parameter. In an exemplary embodiment, the weight and fill height of a radioactive waste container is used to calculate the radioactive waste container density. If the density is above about 2.5 grams per cubic centimeter, the measurement will be deemed not valid and the result “expert

review required” will be generated. Otherwise, the result will be “assay acceptable.” In an exemplary embodiment, another portion of the density comparison involves checking for lumps of plutonium in the radioactive waste container because lumps can cause errors in the measurement. This method involves comparison of the Pu mass value calculated from the 129.29 kilo-electron volt (“keV”) energy region and the 413.71 keV energy region. If the ratio of the 413.71 keV mass divided by the 129.29 kV mass exceeds the predetermined parameter of about 2.5, then the test result is “expert review required.” Otherwise the test result is “assay acceptable.”

[0020] Another application on the host system, in an exemplary embodiment, performs a criticality safety review. The first part of the application is the qualification range test. This application looks up the amount of plutonium found in the assay result, for a particular radioactive waste container, in a table that contains the acceptable ranges of plutonium mass or a qualification mass value. The program checks to see if the assay result for the radioactive waste container is in the acceptable mass range, and, if the radioactive waste container assay result is not in this range, the comparison result is “reject”, otherwise the result is “assay acceptable.” The second part of this application performs a comparison of the total plutonium mass as a percent of container net weight. If this value exceeds a customer-specific low qualification mass value, then the assay results are “reject assay.” In an exemplary embodiment, the customer-specific low qualification mass value is about 10%. A third part of the criticality safety review is a comparison between the total plutonium equivalent mass measured in a particular radioactive waste container and an acceptable amount for the site as determined by the federal government. If the plutonium equivalent mass is over a certain amount, about 220 grams in an exemplary embodiment, then the measurement is not valid and the result of the comparison is “reject.” Otherwise the result of the comparison is “assay acceptable.” The fourth part of this criticality safety review application program includes a fissile gram equivalent comparison. This involves converting the mass results of all isotopes identified in a radioactive waste container to fissile equivalent grams of  $\text{Pu}^{239}$ . If this  $\text{Pu}^{239}$  equivalent mass exceeds a pre-determined limit or parameter, then the assay result

is “reject.” Otherwise, the assay result is “assay acceptable.” In an exemplary embodiment this predetermined limit is about 220 grams for a fissile gram equivalent at about 2 sigma.

[0021] Additionally, the host system 104 application, in an exemplary embodiment, performs comparisons on nuclide totals to ensure that they are within certain limits. The first part of the application calculates the mass ratio of a first isotope  $\text{Pu}^{239}$  to a second isotope  $\text{Am}^{241}$ . The nuclide totals results are used to compare the mass of the  $\text{Pu}^{239}$  to the mass of  $\text{Am}^{241}$ . If the ratio of the  $\text{Pu}^{239}$  mass to the  $\text{Am}^{241}$  mass is less than about 200, the result will be “expert review required”, otherwise the result is “assay acceptable.” The next part of the application analyzes the  $\text{Pu}^{239}$  mass to  $\text{Np}^{237}$  mass ratio. The nuclide totals results are used to compare the ratio of the  $\text{Pu}^{239}$  mass to  $\text{Np}^{237}$  mass. If the ratio of the  $\text{Pu}^{239}$  mass to  $\text{Np}^{237}$  mass is less than about 125, “expert review required” will be the result, otherwise the result is “assay acceptable.” In addition, the application program, in an exemplary embodiment, performs additional isotope identification. The nuclide totals results for  $\text{Np}^{237}$ ,  $\text{U}^{233}$ ,  $\text{U}^{235}$ , and  $\text{U}^{238}$  are reviewed to identify potentially unidentified nuclides. The main energy lines used to identify these isotopes are listed in the table below.

Isotope	Peak Energy Used
$\text{Np}^{237}$	311.90 keV
$\text{U}^{233}$	135.30 keV
$\text{U}^{235}$	185.72 keV
$\text{U}^{238}$	1001.03 keV

If the value of the count rate for any of these isotopes is greater than about 5 times the error, then the test result is “expert review required”, otherwise the result is “assay acceptable”. If the results of the isotopic measurement data confirms the presence of  $\text{Np}^{237}$ , the  $\text{Np}^{237}$  nuclide totals result test is not performed. If the results of the isotopic measurement data confirms the presence of  $\text{U}^{235}$ , the  $\text{U}^{235}$  nuclide totals result test is not



performed.

[0022] In an exemplary embodiment of the present invention, an application on the host 104 performs a review of segment information in an effort to determine if measurements of individual segments of the drum are valid. Each segment is reviewed for transmission source results. The transmission source peaks with an energy less than about 400 keV are considered the low energy peaks. If the 400 keV transmission source peak intensity is less than about 1 percent of the calibrated intensity, the test result is "expert review required." If a low energy transmission source peak intensity other than the 400 keV peak is less than or equal to about 0.1 percent of its calibrated intensity, the result is "expert review required." Calibrated intensity means the intensity that the peak was at during the transmission calibration. Another part of the segment application program looks at pulser/reference source results. These results help determine if the radioactive waste container and its matrix are too dense for accurate mass results. Two possible methods are used. Both are outlined here. The first method described uses a reference pulser. This pulser is set at a pre-determined energy during calibration. During an assay, this energy is checked to find the pulser peak. If the pulser peak is not found, the result will be "expert review required." If the peak is found but the total number of counts in the peak is less than about 3,000, "expert review required" will be the result. The second method uses a reference source. This method uses a radioactive source that has a known reference source peak energy. This reference energy peak is searched for and if the source peak is not found, "expert review required" will be the result. If the peak is found, "expert review required" will be the result if the total counts in the source peak is less than about 50% of the calibrated rate. Calibrated rate means the count rate of the source or reference peak determined at the time that the transmission calibration was performed.

[0023] Still another portion of the application program that reviews segment information is the live time results. Real time is defined as live time plus dead time. Live time is the time during an assay that the detector is available to process counts. Dead time is the time during which the detector electronics are processing a count and are

unavailable to collect counts. The live time results are checked for each segment. If the value of live time divided by real time is less than about 0.3, then “expert review required” will be the result. In an exemplary embodiment, the localized concentrations are also analyzed by this application program. This involves looking at the concentration in the bottom of the radioactive waste container. If the concentration is too high then the result is “expert review required.” The bottom two segments are reviewed, and if the total activity, based on the 413.71 keV peak area, in the bottom two segments is greater than about 50% of the total activity in the radioactive waste container, then the result is “expert review required.” A segment is an imaginary horizontal disc of the radioactive waste container seen by the detector. In an exemplary embodiment, a segment is between one half an inch and one inch in height.

**[0024]** Storage device 108 may be implemented using a variety of devices for storing electronic information such as a file transfer protocol (FTP) server. It is understood that storage device 108 may be implemented using memory contained in a host system 104 or may be a separate physical device. Storage device 108 contains a variety of information including an automated independent technical review template, the item description code data, and the counter data. Storage device 108 may also contain information concerning the submission of the report request or transmittal of automated independent technical review data (e.g. a user identifier, date and time of submission).

**[0025]** FIG. 2 is a flowchart of an exemplary process for performing an automated independent technical review. At step 200 the assay results are received and at step 202 the assay results are evaluated in order to determine if they are within established guidelines. If the assay results are within the established guidelines, step 204 is performed and the assay review is accepted and the process is completed. If the assay results are not within the established guidelines, step 206 is performed in order to determine if a technical review is required. If a technical review is required, a technical review comment template that includes the type of technical review to be performed is created at step 208. Once this comment template is created, the process is complete. If a technical review is not required, step 210 is performed and the assay is rejected. After

step 210 is performed, the process is complete.

**[0026]** FIG. 3 depicts an exemplary independent technical review template. The review template has a heading “Independent Technical Review Report” 302 in order to identify the report type. Next, the review template contains information 304 that identifies the particular data being tested and referred to in the report. In an exemplary embodiment this includes item identification which is used to identify the assay data package being tested. The identification information 304 also includes an item description code that represents the material that was in the radioactive waste container being tested. The data and time of the assay are also included in order to indicate when the waste package was assayed. A counter identification is used to determine the assay equipment upon which the waste package was counted. The identification information 304 can also include a sequence number which is used as a unique identifier for that particular set of assay data.

**[0027]** The review template also includes a section for describing the test that were performed 306. The review template in FIG. 3 has some examples of tests that could be performed. Any of the tests described earlier in reference to FIG. 1 could be listed in this section 306. These tests include determining whether an assay result is within a predetermined parameter. Along with a list of the test performed 306, the review template includes a section for the results 308 of the tests. As discussed in reference to FIG. 1 the results could be “assay acceptable”, “expert review required”, or “reject.” Next, the review template contains a space for the final disposition 310 of the test. If all tests for the radioactive waste container are “assay acceptable”, then the final disposition 310 will indicate the assay review is acceptable. If any test result is “expert review required”, an independent technical review comment sheet, as shown in FIG. 4, will be generated and the final disposition 310 will indicate that technical review is required. If the final disposition 310 is “reject”, generation of an independent technical review comment sheet will be suppressed. In an exemplary embodiment the review template also includes a place for the independent technical reviewer to sign 312 and date 314 the report.

**[0028]** FIG. 4 depicts an exemplary independent technical review comment template. The comment template contains a header 402 with the report title, “independent technical review comment sheet.” Next, the comment template contains information 404 that identifies the particular data being tested and referred to in the report. In an exemplary embodiment, this information is the same as the data described above in reference to 304 in FIG. 3. Next, the comment template contains a space to describe the data requiring review 406. This section 406 will contain a list of the tests that resulted in the rating “expert review required.” Section 408 of the comment template contains space for comments and disposition information. In an exemplary embodiment, the comment template also includes a place for the technical reviewer to sign 410 and date 412 the report.

**[0029]** As described above, the user system 102 and the host system 104 can share the processing. For example, the user system 102 may include a software application that allows the user system to create a report request without assistance from the host system 104. The user system 102 would then contact the host system 104 to generate the report. Alternatively, the host system 104 may provide an application to the user system 102 (e.g., an applet) once the user system 102 contacts the host system 104. Accordingly, processing can be shared by the two systems.

**[0030]** As described above, the present invention can be embodied in the form of computer-implemented processes and apparatuses for practicing those processes. The present invention can also be embodied in the form of computer program code containing instructions embodied in tangible media, such as floppy diskettes, CD-ROMs, hard drives, or any other computer-readable medium, wherein, when the computer program code is loaded into and executed by a computer, the computer becomes an apparatus for practicing the invention. The present invention can also be embodied in the form of computer program code, for example, whether stored in a storage medium, loaded into and/or executed by a computer or transmitted over some transmission medium, such as over electrical wiring or cabling, through fiber optics, or via electromagnetic radiation, wherein, when the computer program code is loaded into and executed by a computer, the

computer becomes an apparatus for practicing the invention. When implemented on a general-purpose microprocessor, the computer program code segments configure the microprocessor to create specific logic circuits.

[0031] It will be evident to those skilled in the art that the present invention provides many improvements over the current state of the art of performing automated independent technical reviews. Using this invention will eliminate human error in the independent review process, create a more consistent review process, create a more reliable review process, and provide a more consistent review process.

[0032] While the invention has been described with reference to exemplary embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiments for carrying out this invention, but that the invention will include all embodiments falling within the scope of the appended claims.